

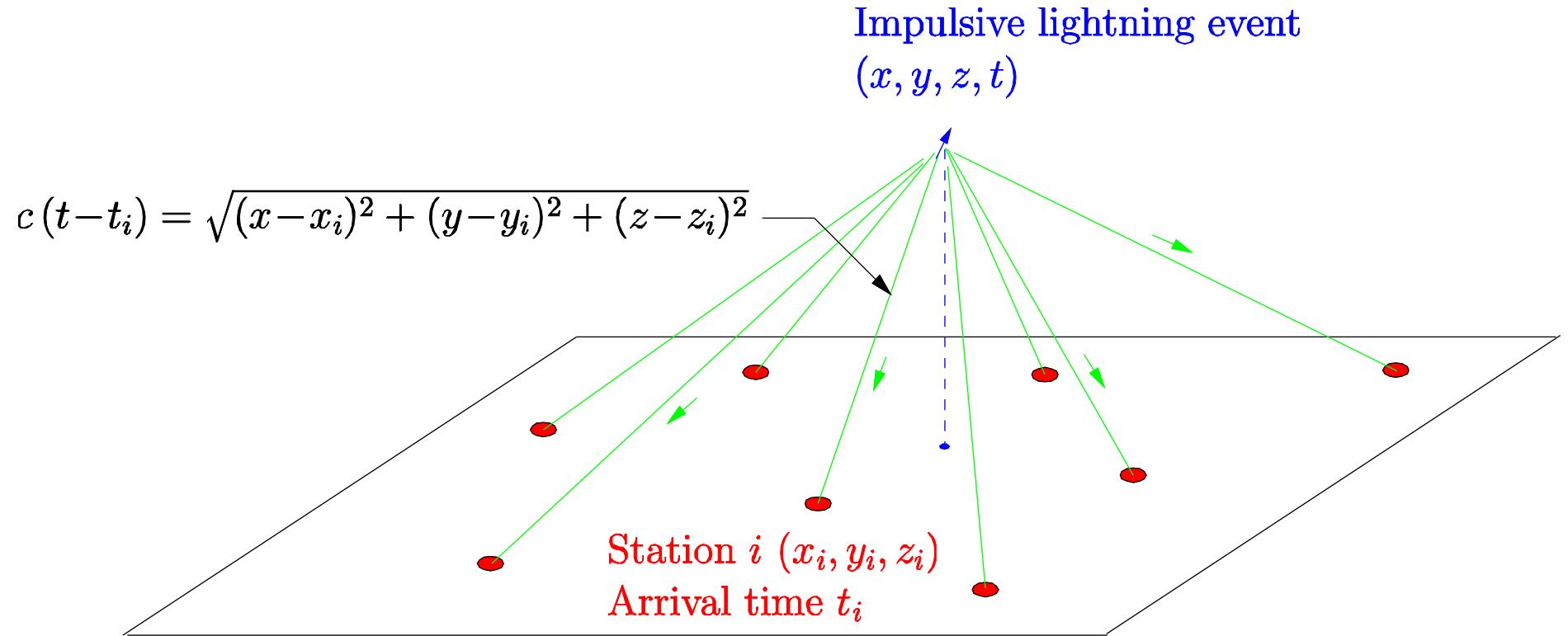
Status Report on Several Lightning Mapping Arrays

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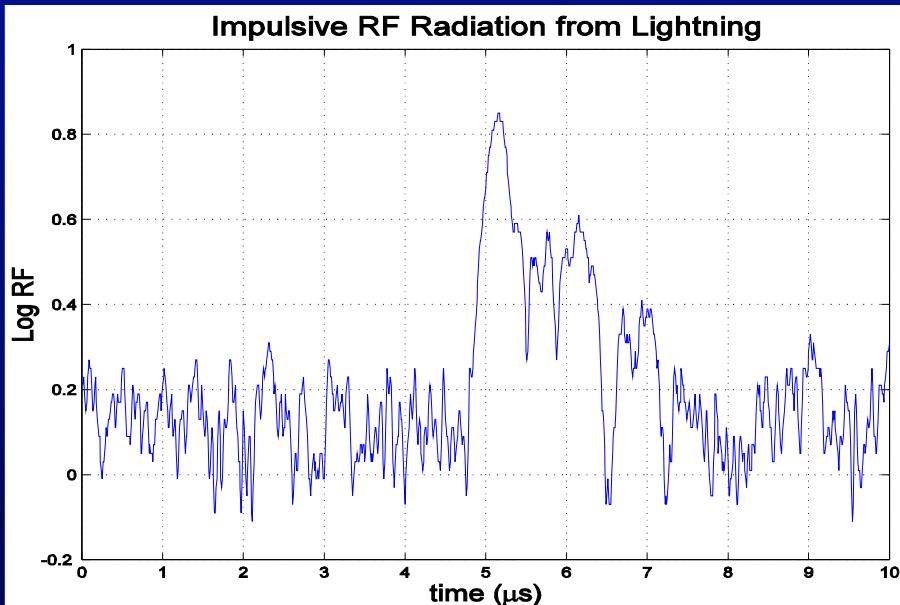
Southern Thunder 2011
Norman, OK July 11, 2011

Time-of-Arrival (TOA) technique:

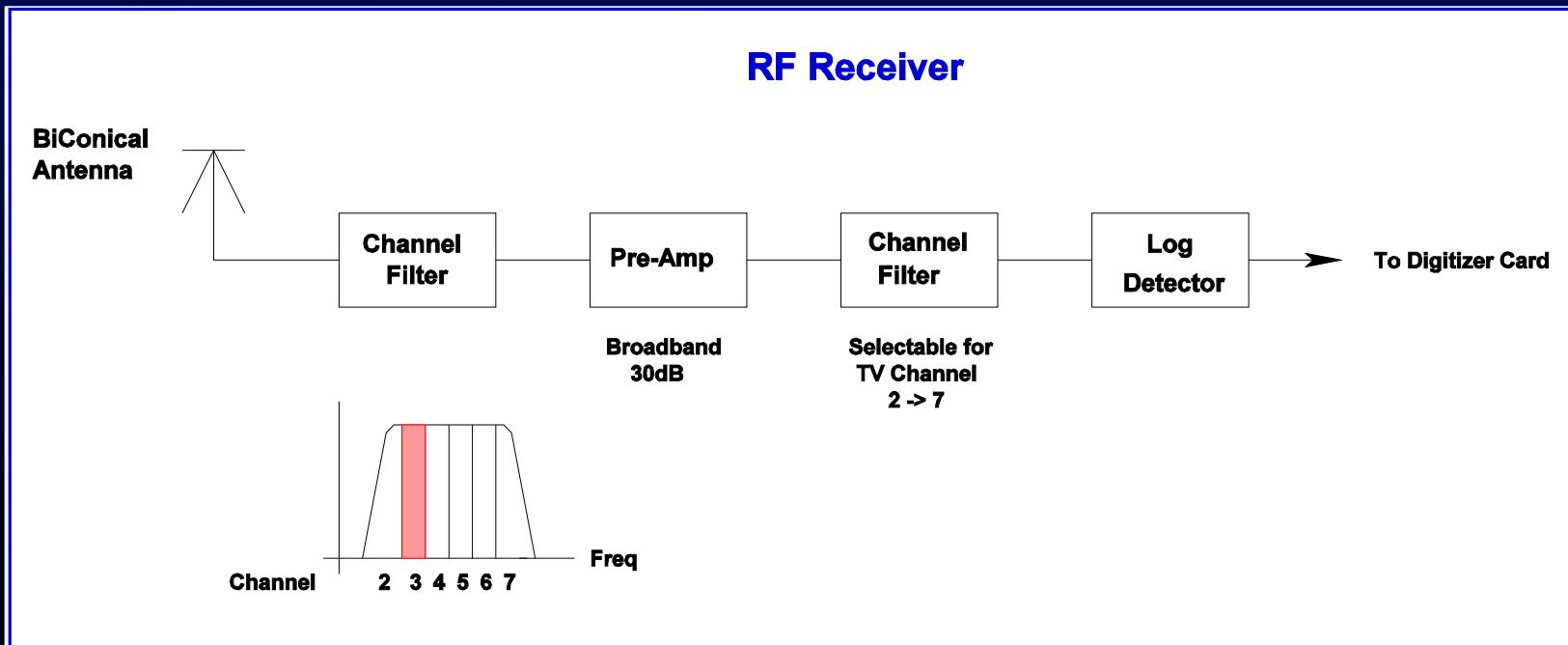


- Measure t_i at $N \geq 4$ locations (50 ns accuracy)
- Solve for x, y, z, t (4 unknowns)
- Inherently 3-dimensional technique

LMA Operation



- Listen in a locally unused TV channel
- Detect peak event in successive 80 microsecond time intervals
- Measure arrival time within 40 ns
- Up to 12,500 arrival times/second (100,000 in research mode)

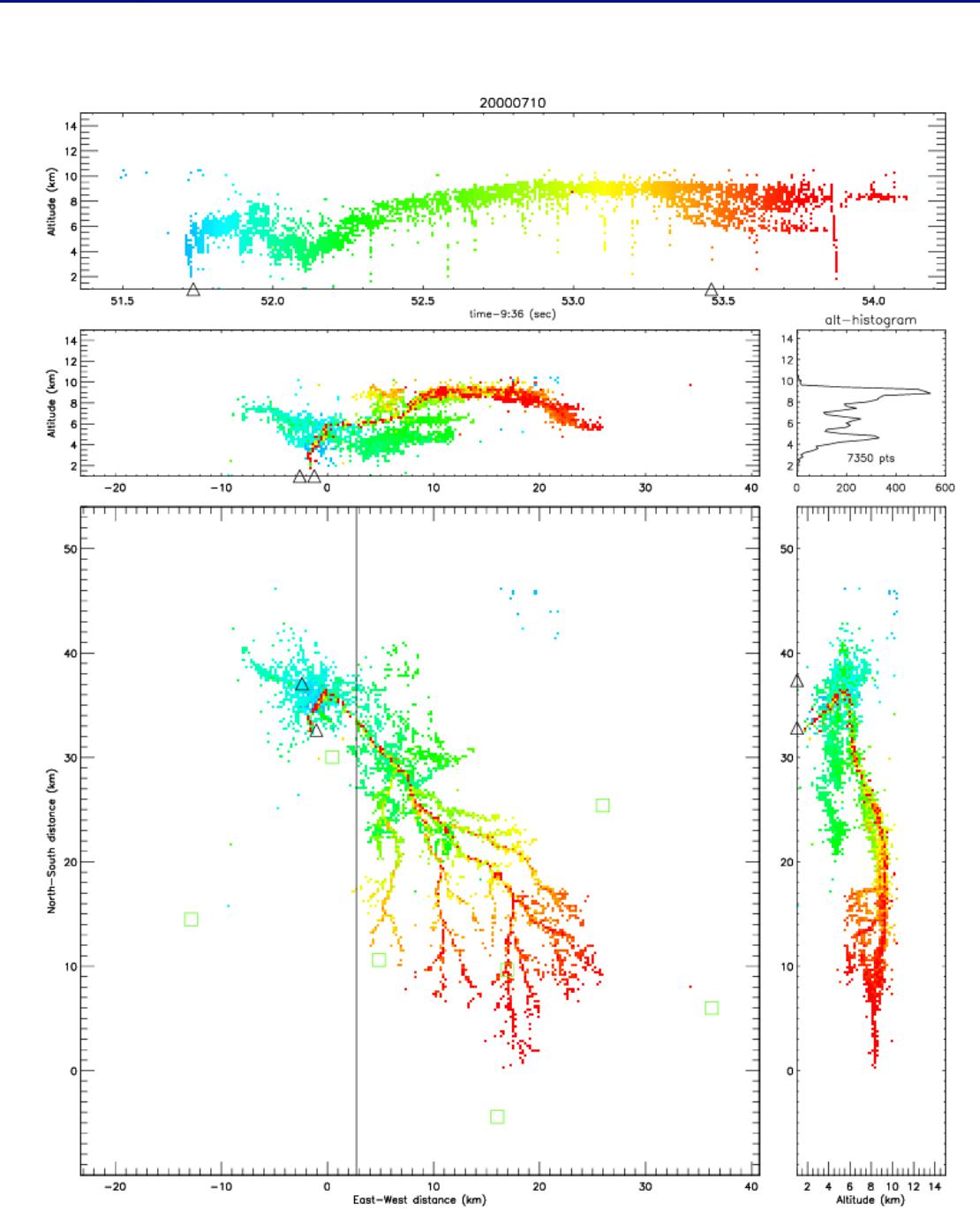


Example of a highly dendritic negative cloud-to-ground (CG) flash

Height vs. E-W

60 km extent,
2.5 sec duration,
7350 sources

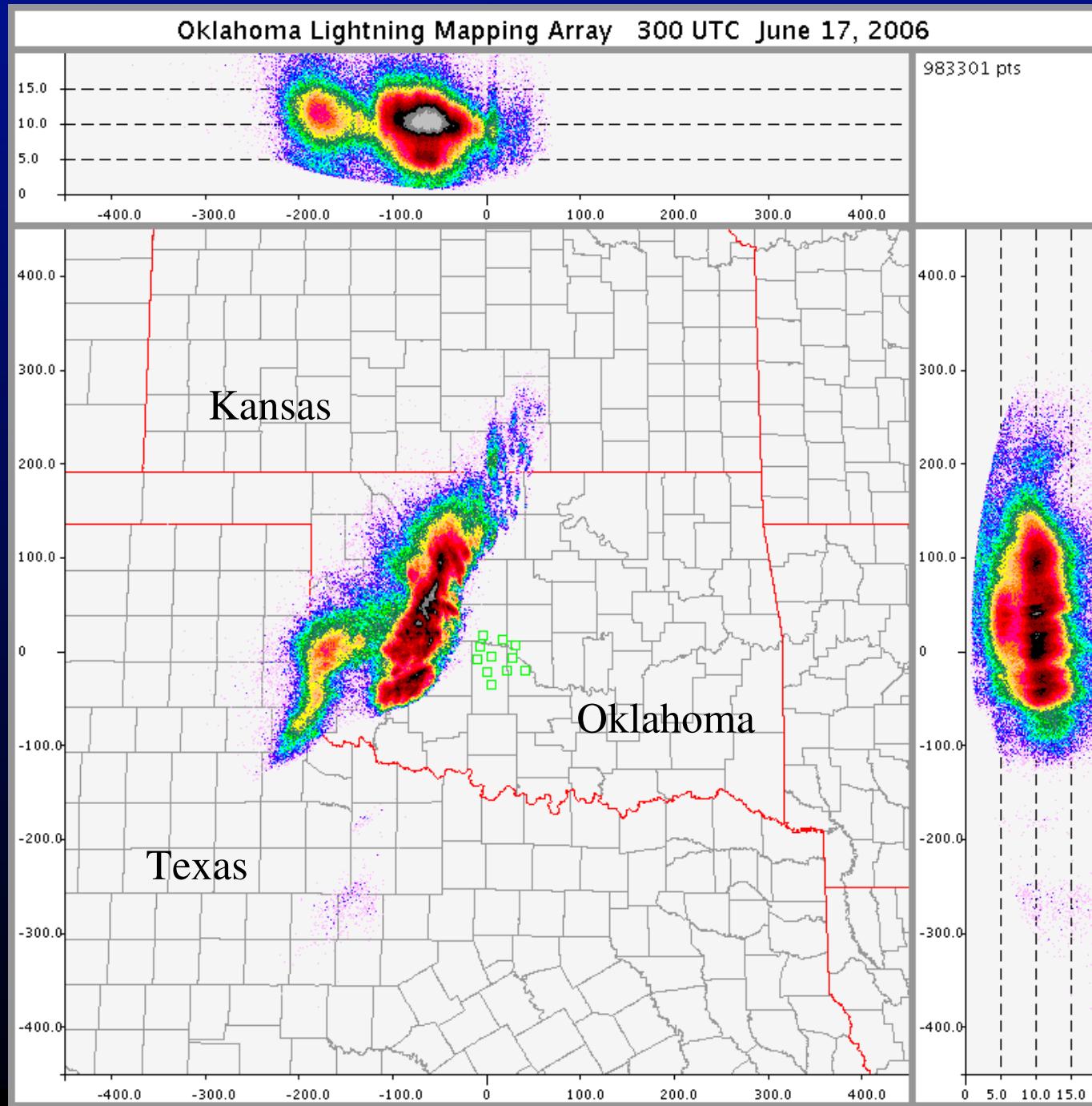
Plan view



Height vs. time

Height vs. N-S

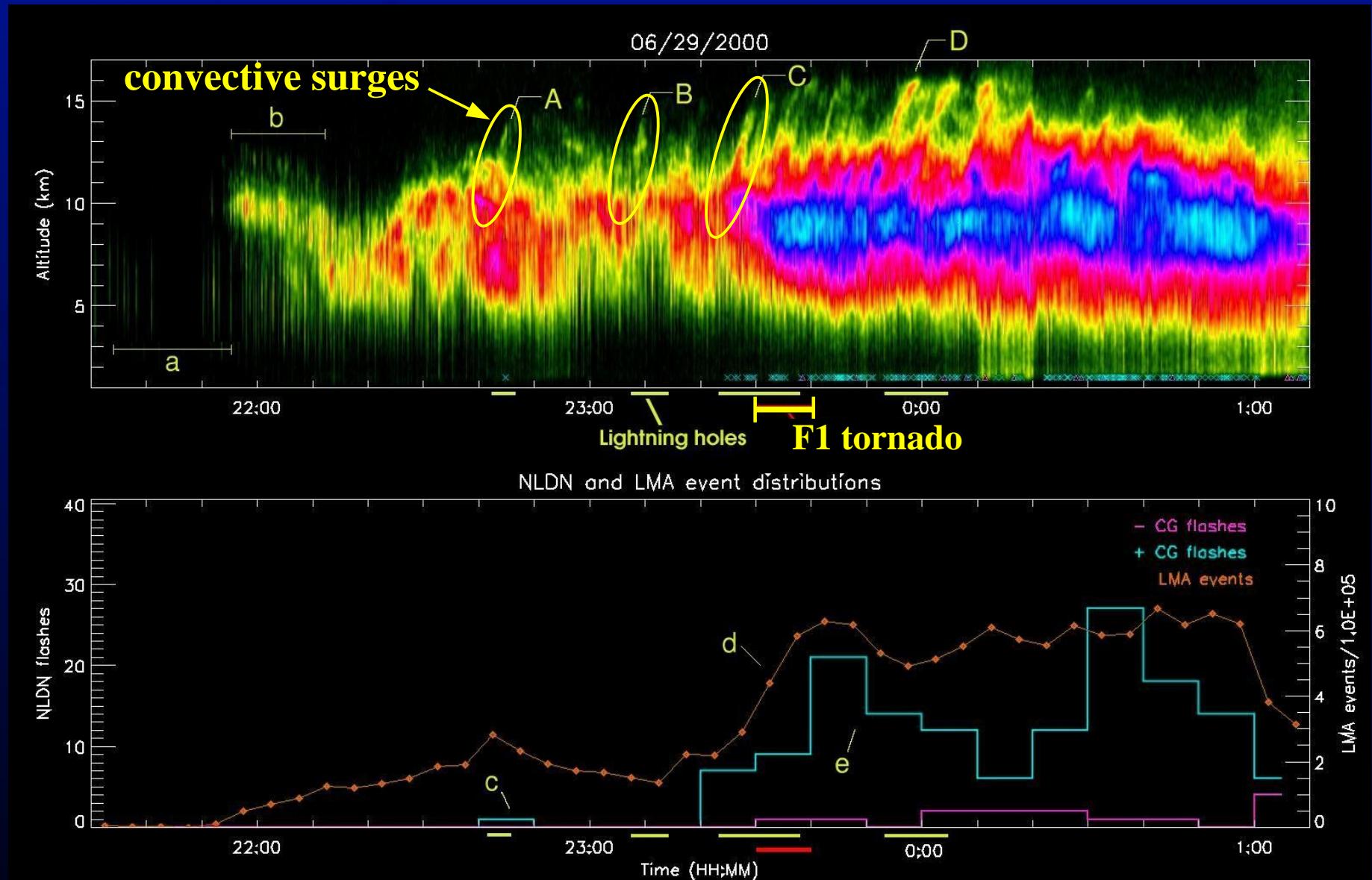
Oklahoma Lightning Mapping Array (OU, NSSL)



- Density of points display

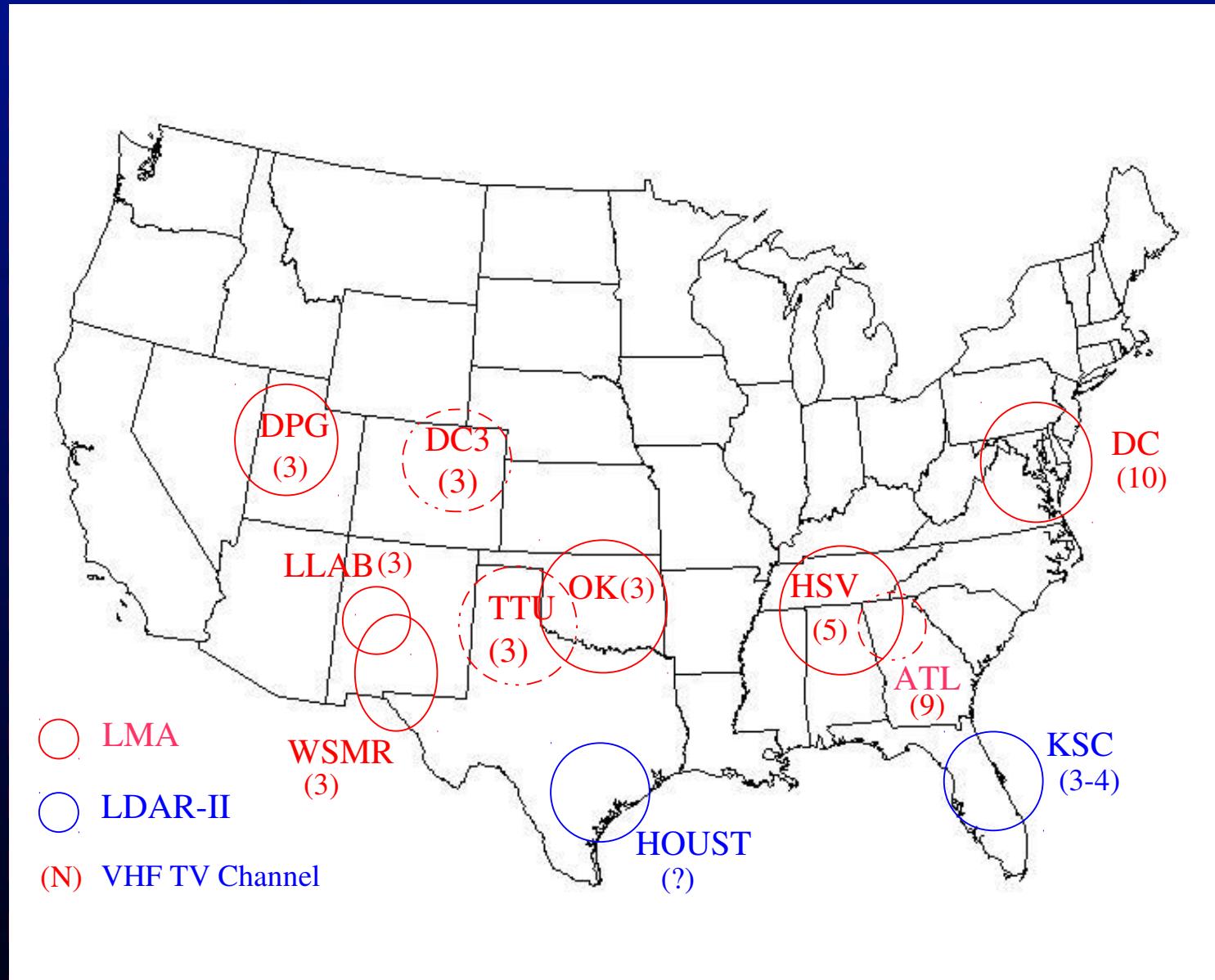
(<http://lightning.nmt.edu/oklma>)

Tornadic Storm, June 29, STEPS 2000: Height vs. time density plot

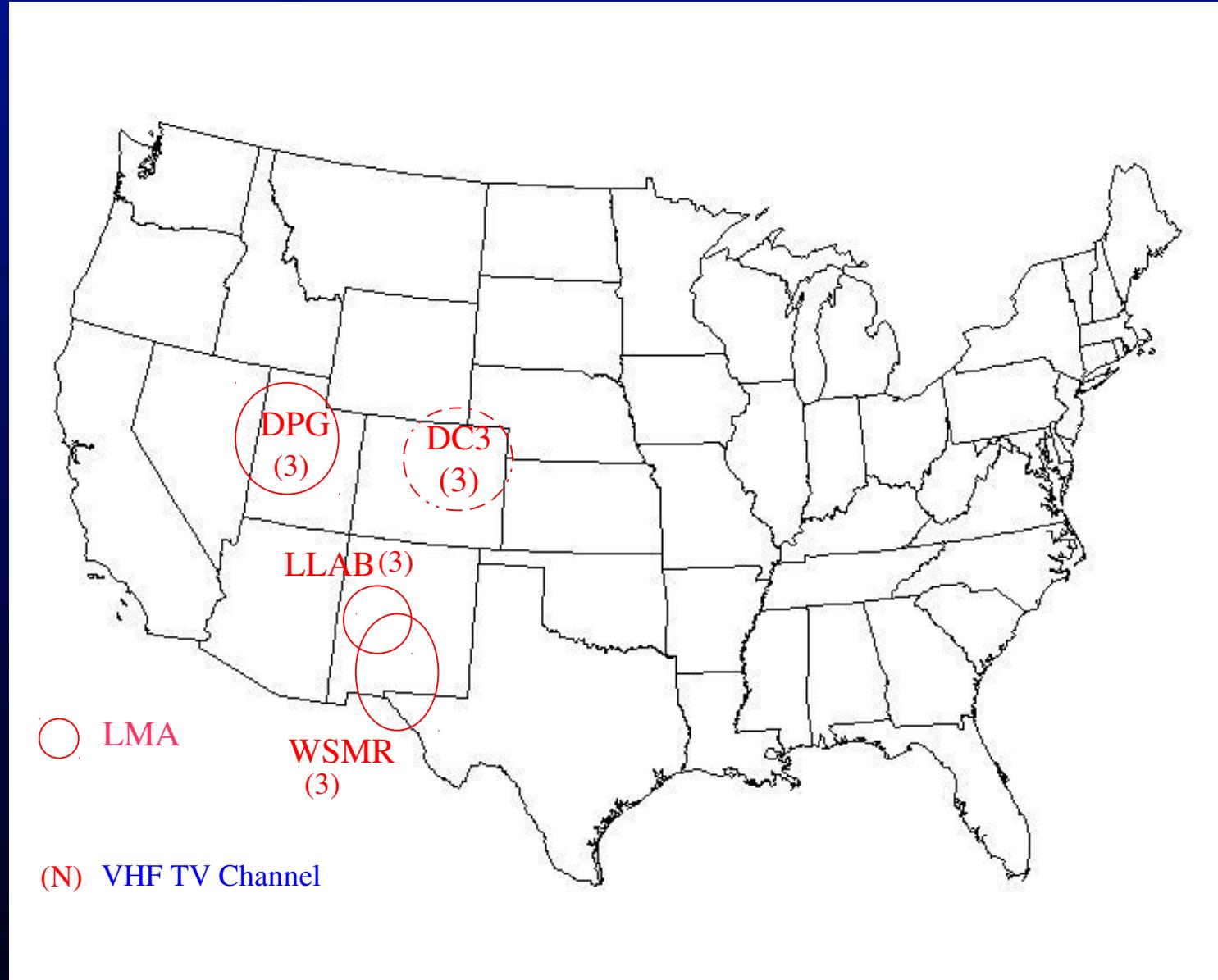


F1 tornado preceded by 2 convective surges (A, B) 45 min earlier;
accompanied by 3rd surge and by onset of +CG discharges

VHF Time-Of-Arrival (TOA) Total Lightning Mapping Systems



VHF Time-Of-Arrival (TOA) Total Lightning Mapping Systems



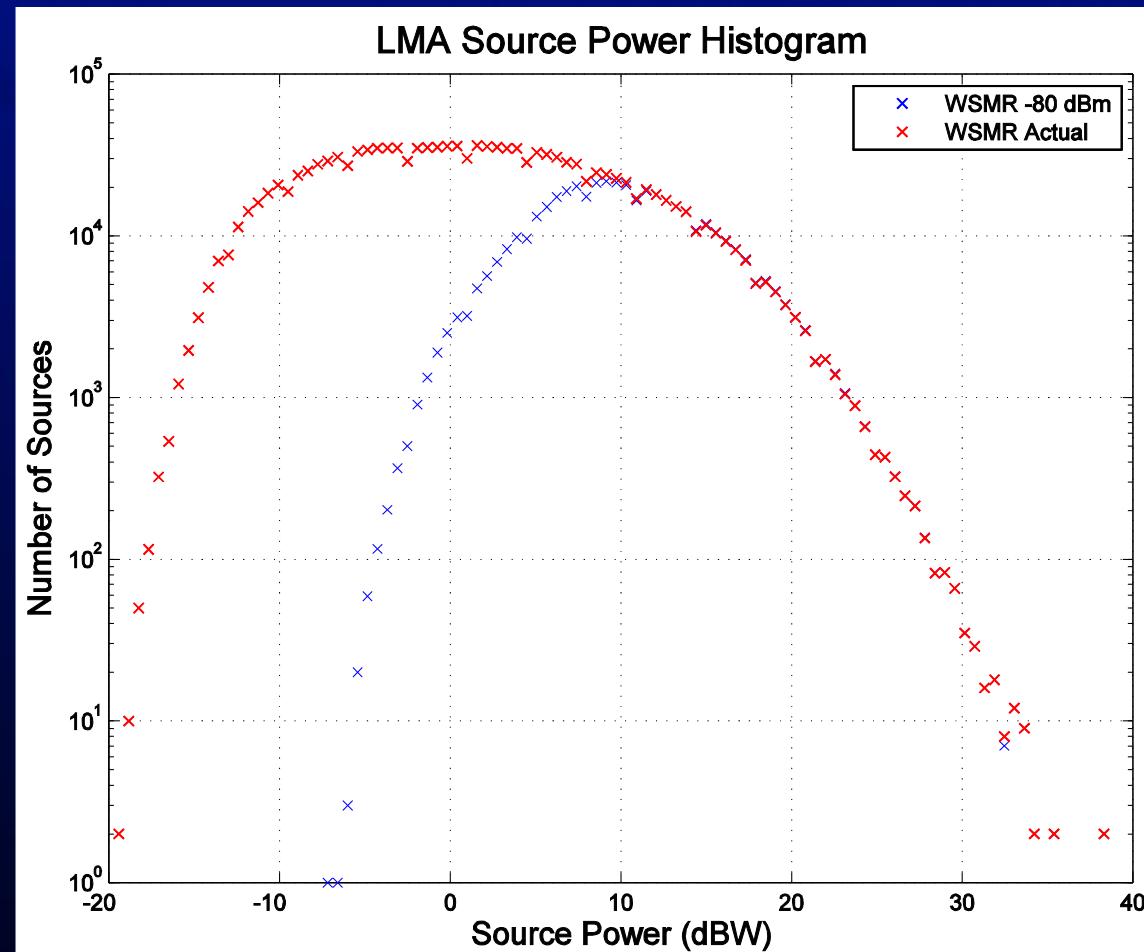
Practical Considerations

- VHF Frequency: Lightning measurements are best made in the lower VHF
 - Radiated source power decreases as $\sim 1/f^2$
 - Antenna gain decreases as $1/f^2$ [(1/2)-wave dipole antennas]
 - Decreased detectability, range in upper VHF
- Array Size
 - Station spacing of ~20 km necessary for 3D accuracy and good sensitivity
- Number of Stations
 - Better accuracy and detectability with more stations
 - Minimum number: 10
- Background Noise
 - Lower background gives higher sensitivity
 - Getting away from buildings lowers noise considerably
 - Newer deployments (Langmuir Lab, DPG, TTU, DC3) use solar power in order to get away from local noise sources

• WSMR Lightning Mapping Array

- Number of sources detected: **717316**
- Number of sources at -80 dBm: 438162

Station	Noise Floor
C	-85 dBm
G	-89 dBm
H	-91 dBm
K	-82 dBm
L	-73 dBm
M	-82 dBm
P	-90 dBm
T	-73 dBm
W	-90 dBm





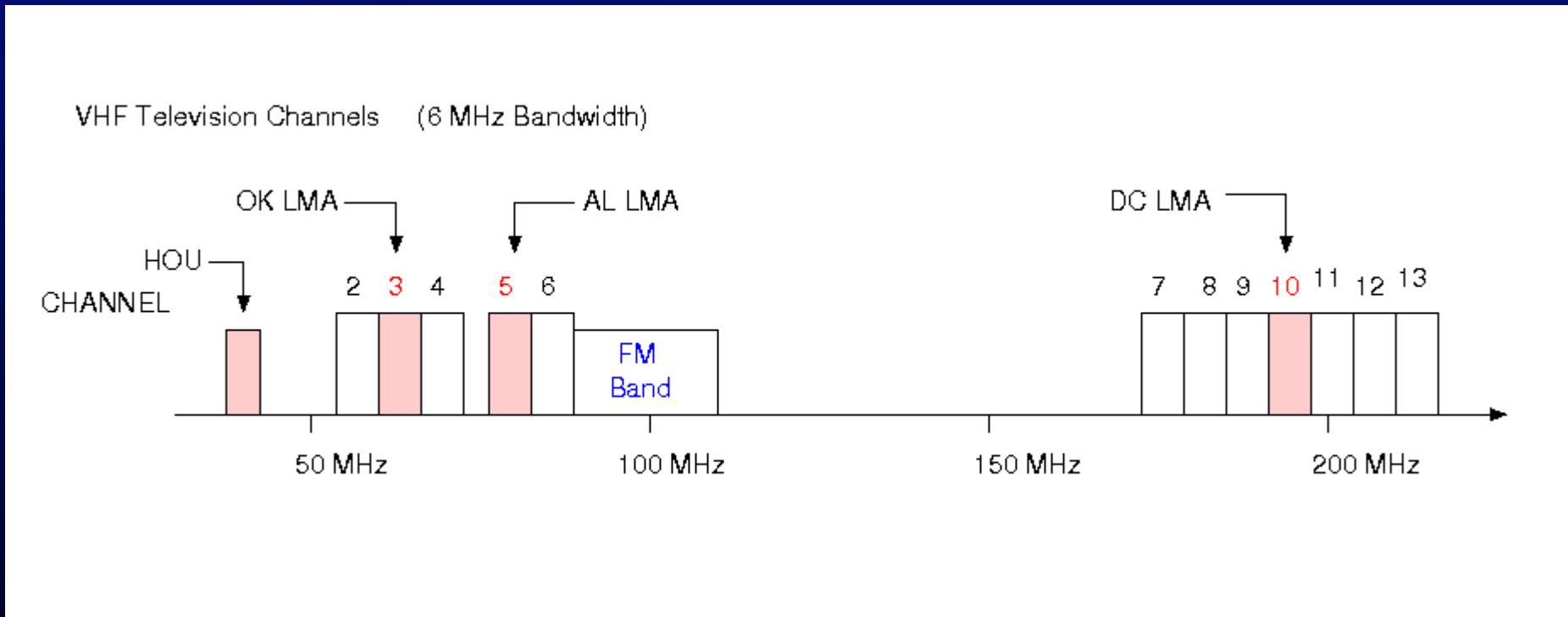
Solar Powered LMA Station

- Noise threshold: ~ -90 dBm

Practical Considerations (continued)

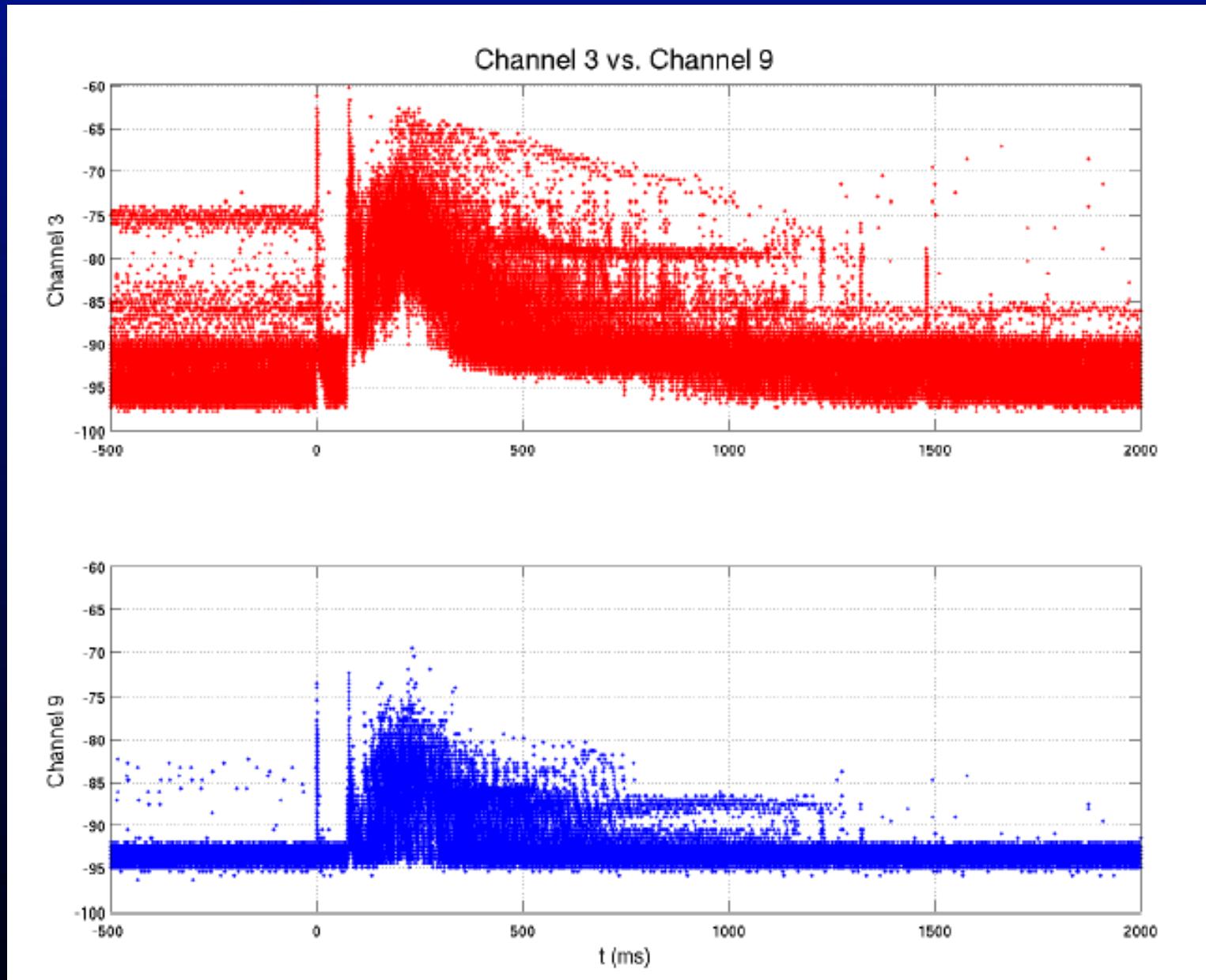
- Communications Link
 - Need 50 Kb/sec to each station for decimated real-time data
 - Need 1 Mb/sec for full data
 - 802.11 Wireless (OKLMA, NALMA)
 - Internet (DC)
 - Fiber Optic (WSMR)
 - Cell Phone Modem (DC3)

VHF Frequency Spectrum

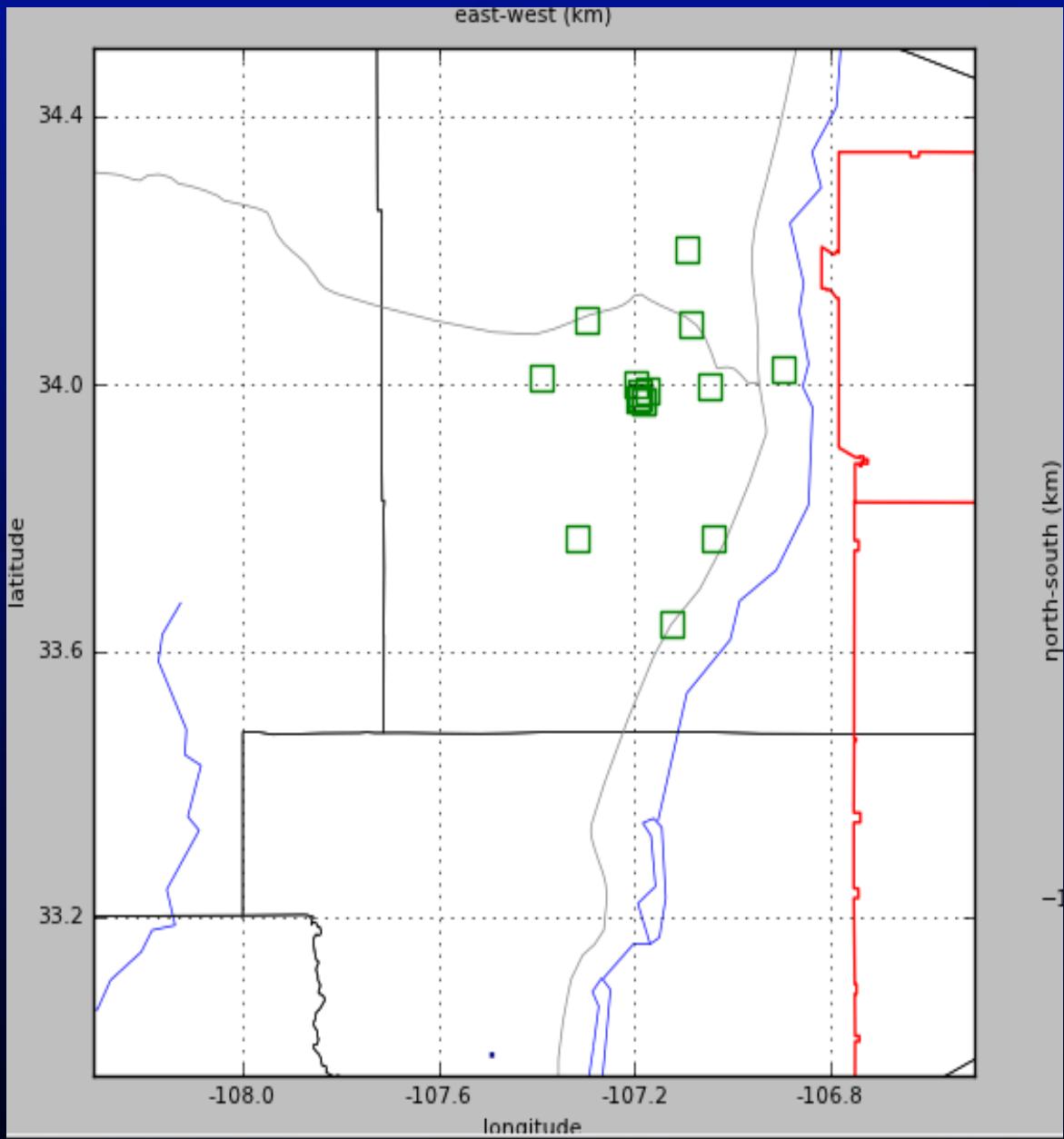


LMA stations ‘listen’ on a locally unused TV channel (e.g., Ch. 3)

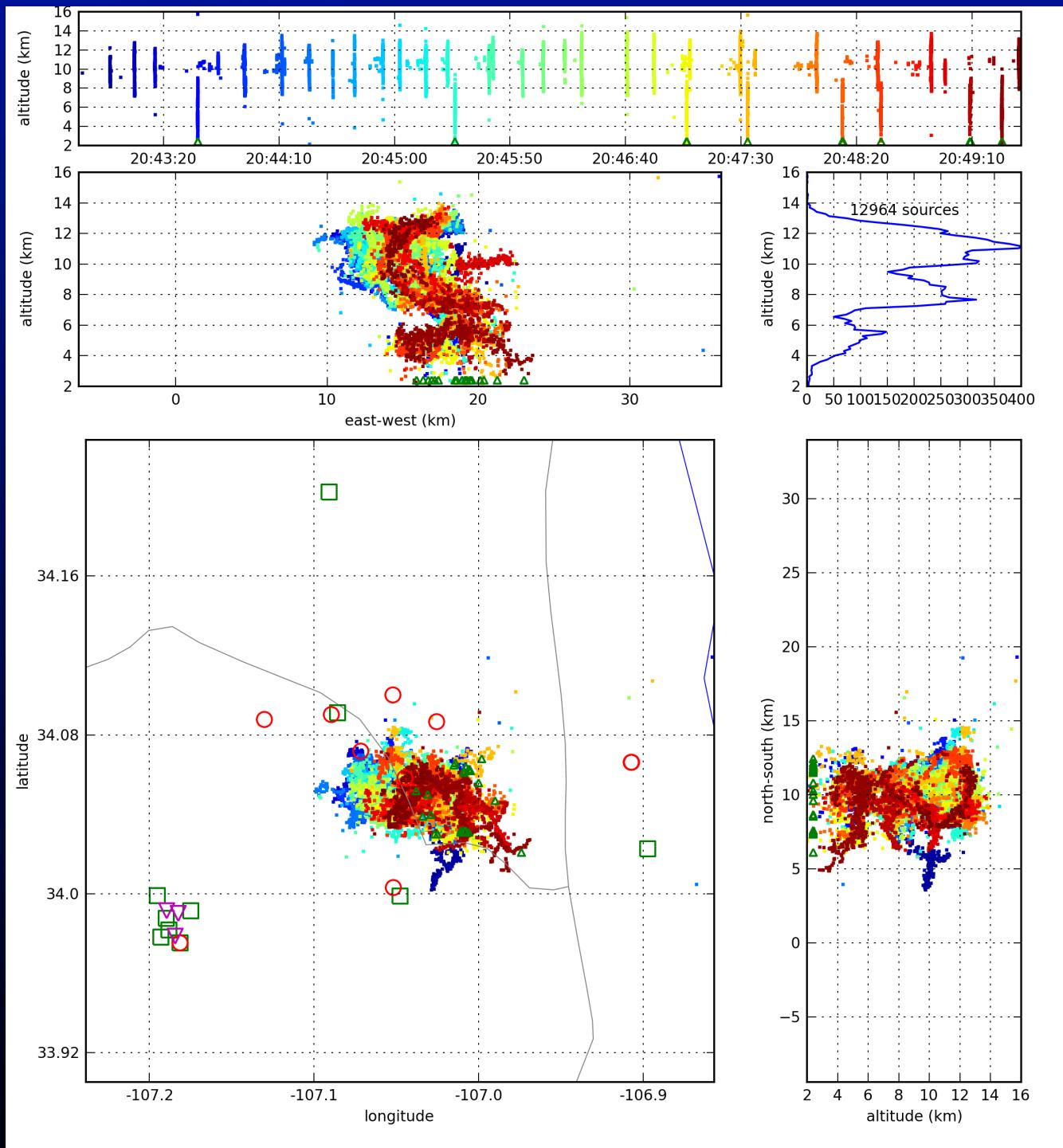
Total Lightning Observations

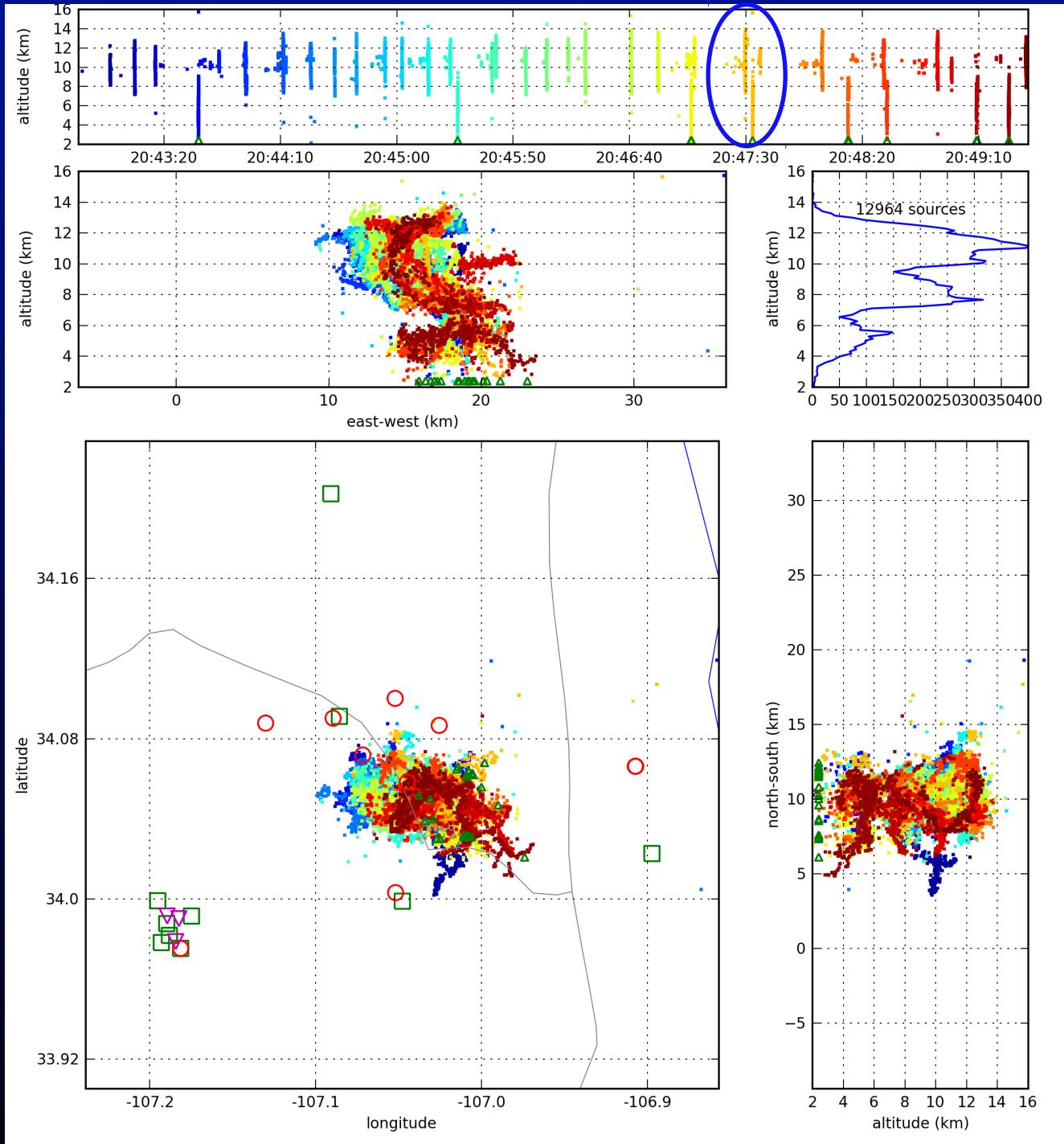


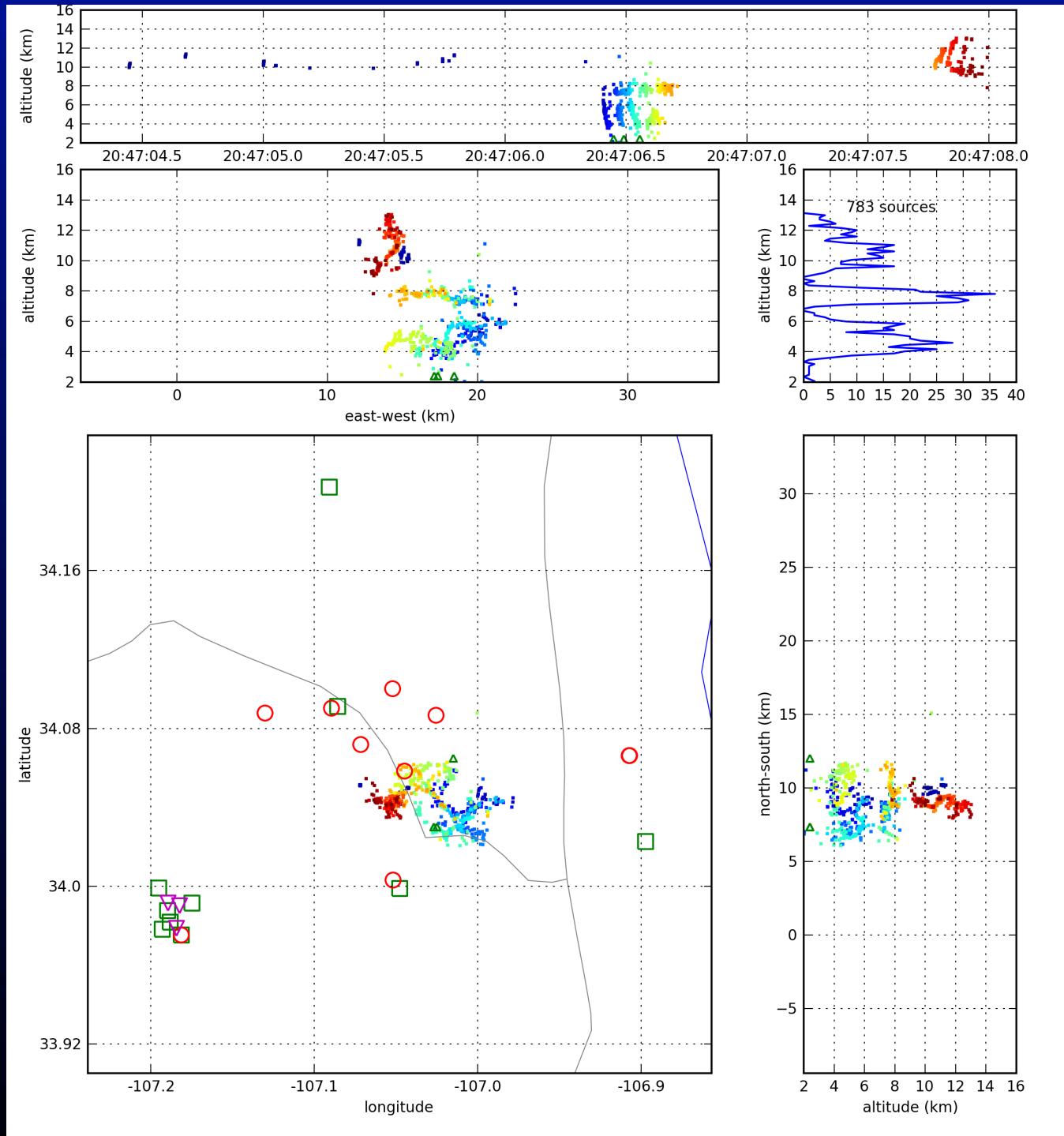




- ## Langmuir Lab LMA
- 16-Station Network
 - 10-Station “Normal” LMA
 - 6-Station “Compact” LMA
 - Most stations solar powered
 - Wireless 802.11b Comms
 - LiveLMA Display

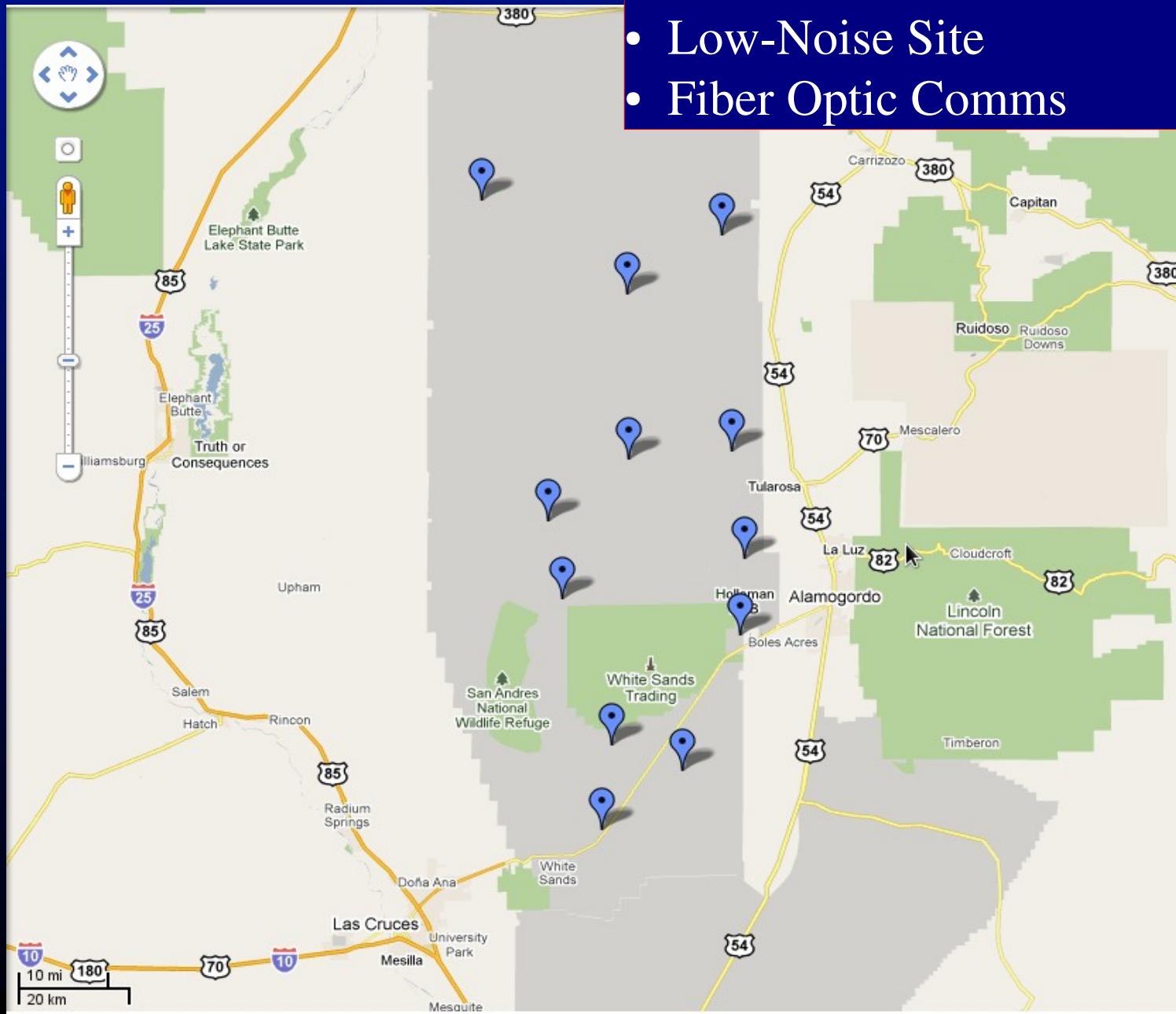


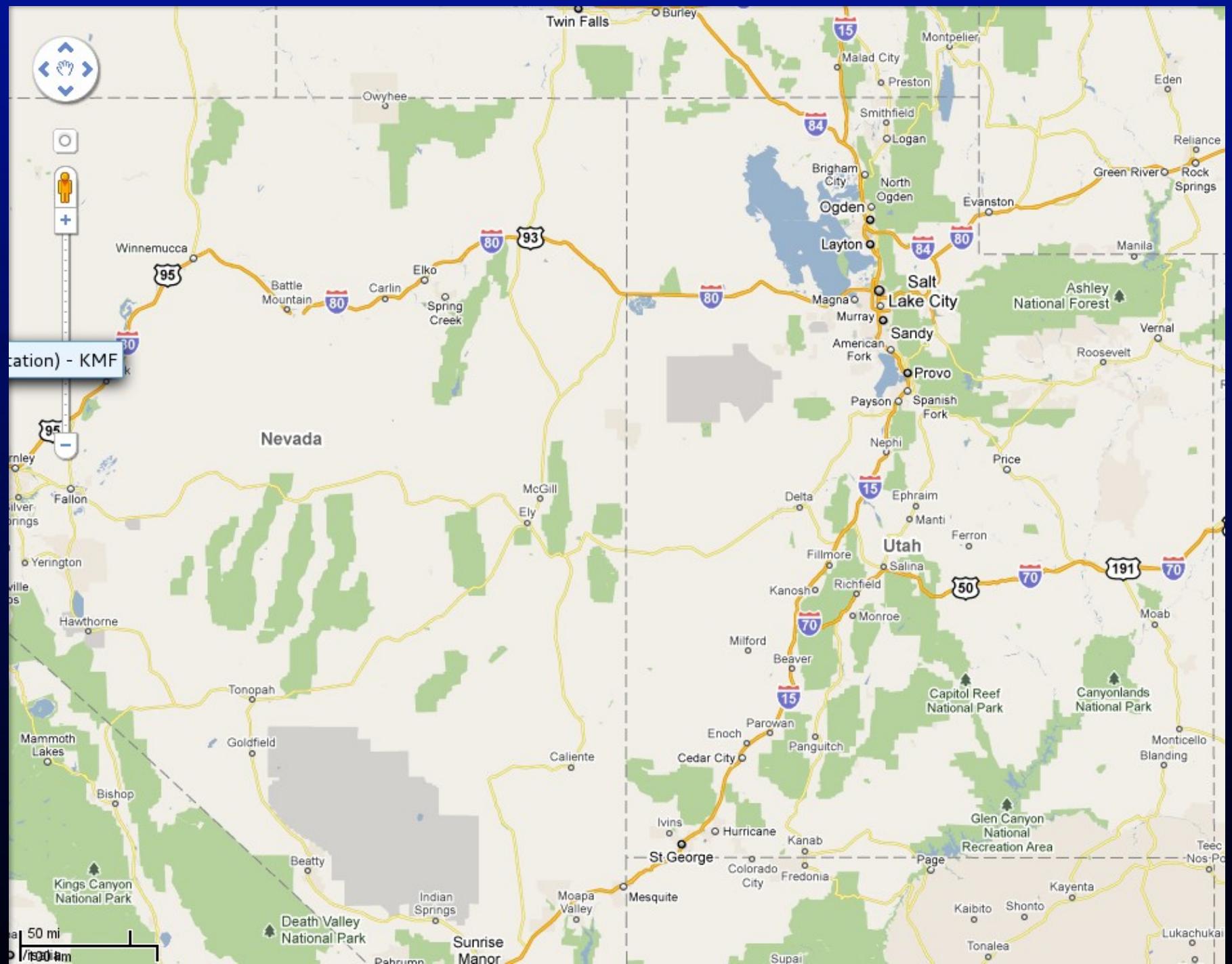




WSMR LMA

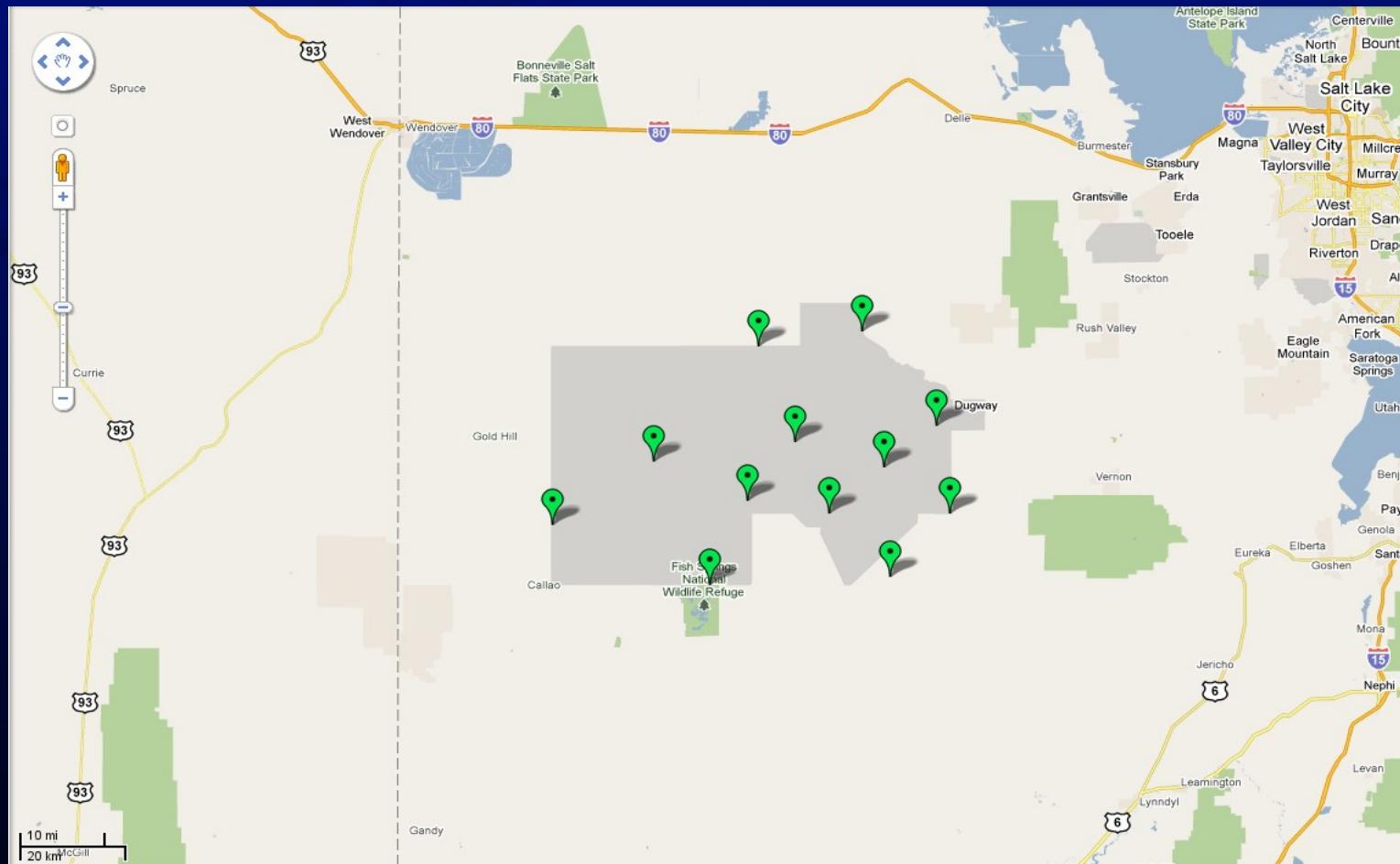
- Installed in 2004
- 12-Station Network (2 more soon)
- AC Powered
- Low-Noise Site
- Fiber Optic Comms



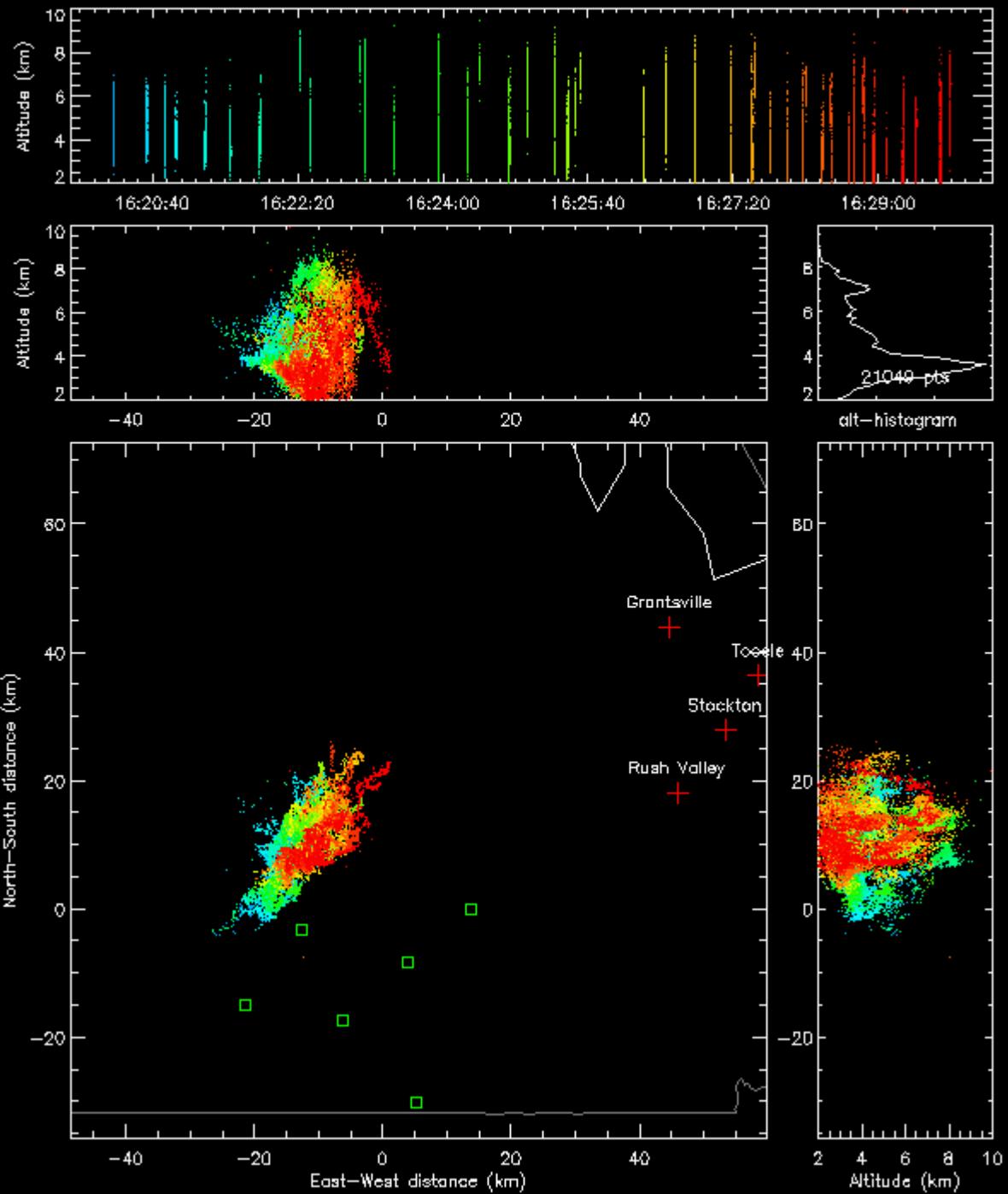


Dugway Proving Grounds LMA

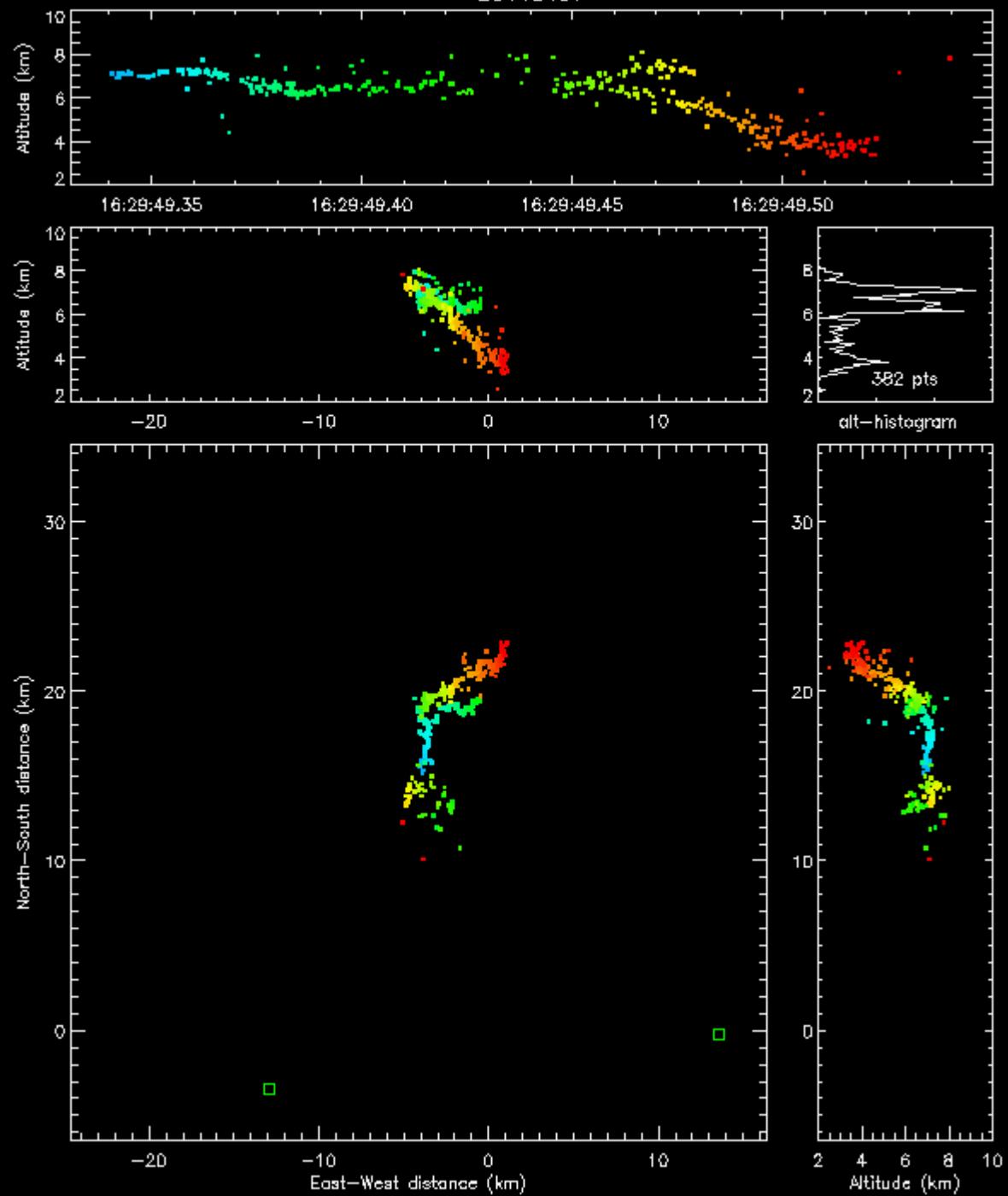
- 12 Station Network
- Solar Powered
- Very Noise Network
- Limited Comms



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DC3 LMA (Deep Convective Clouds & Chemistry Experiment)

- 16-Station Network in Northeastern Colorado, Spring 2012
- Solar Powered
- Cell Phone Modem Comms
- Transition to Colorado Front Range LMA after DC3 Project

